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PATENT COOPERATION TREAT

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 11 June 2001 (11.06.01)	
International application No. PCT/GB00/03746	**Applicant's or agent's file reference** MCM/PWJ/21579
International filing date (day/month/year) 29 September 2000 (29.09.00)	**Priority date** (day/month/year) 30 September 1999 (30.09.99)
Applicant LANGLEY, Richard, Jonathan et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

12 April 2001 (12.04.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Pascal Piriou
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

GB0003746

Record

29/9

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* MCM/PWJ/21579

Box No. I TITLE OF INVENTION

DUAL-BAND MICROSTRIP ANTENNA

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Harada Industries (Europe) Limited
Bell Heath Way
Woodgate Business Park
Clapgate Lane
Birmingham, B32 3BZ
United Kingdom

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: UNITED KINGDOM

State *(that is, country)* of residence: UNITED KINGDOM

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

LANGLEY: Richard Jonathan
Harada European Technology Centre
Research and Development Building
University of Kent
Canterbury, Kent CT2 7PD
United Kingdom

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: UNITED KINGDOM

State *(that is, country)* of residence: UNITED KINGDOM

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

MOIR; MICHAEL CHRISTOPHER
MATHYS & SQUIRE
100 Gray's Inn Road
London
WC1X 8AL
UNITED KINGDOM

Telephone No.
+44 (0) 20 7 830 0000

Facsimile No.
+44 (0) 20 7 830 0001

Teleprinter No.

☐ **Adress for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. 2 ......

Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

VIRATELLE: Didier
Harada European Technology Centre
Research and Development Building
University of Kent
Canterbury, Kent CT2 7PD
United Kingdom

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: FRENCH

State *(that is, country)* of residence: UNITED KINGDOM

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No. V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*.

Regional Patent

- [X] **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- [X] **EA** Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- [X] **EP** European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- [X] **OA** OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*.

- [X] **AE** United Arab Emirates
- [X] **AL** Albania
- [X] **AM** Armenia
- [X] **AT** Austria
- [X] **AU** Australia
- [X] **AZ** Azerbaijan
- [X] **BA** Bosnia and Herzegovina
- [X] **BB** Barbados
- [X] **BG** Bulgaria
- [X] **BR** Brazil
- [X] **BY** Belarus
- [X] **CA** Canada
- [X] **CH and LI** Switzerland and Liechtenstein
- [X] **CN** China
- [X] **CU** Cuba
- [X] **CZ** Czech Republic
- [X] **DE** Germany
- [X] **DK** Denmark
- [X] **EE** Estonia
- [X] **ES** Spain
- [X] **FI** Finland
- [X] **GB** United Kingdom
- [X] **GD** Grenada
- [X] **GE** Georgia
- [X] **GH** Ghana
- [X] **GM** Gambia
- [X] **HR** Croatia
- [X] **HU** Hungary
- [X] **ID** Indonesia
- [X] **IL** Israel
- [X] **IN** India
- [X] **IS** Iceland
- [X] **JP** Japan
- [X] **KE** Kenya
- [X] **KG** Kyrgyzstan
- [X] **KP** Democratic People's Republic of Korea
- [X] **KR** Republic of Korea
- [X] **KZ** Kazakhstan
- [X] **LC** Saint Lucia
- [X] **LK** Sri Lanka
- [X] **LR** Liberia
- [X] **LS** Lesotho
- [X] **LT** Lithuania
- [X] **LU** Luxembourg
- [X] **LV** Latvia
- [X] **MD** Republic of Moldova
- [X] **MG** Madagascar
- [X] **MK** The former Yugoslav Republic of Macedonia
- [X] **MN** Mongolia
- [X] **MW** Malawi
- [X] **MX** Mexico
- [X] **NO** Norway
- [X] **NZ** New Zealand
- [X] **PL** Poland
- [X] **PT** Portugal
- [X] **RO** Romania
- [X] **RU** Russian Federation
- [X] **SD** Sudan
- [X] **SE** Sweden
- [X] **SG** Singapore
- [X] **SI** Slovenia
- [X] **SK** Slovakia
- [X] **SL** Sierra Leone
- [X] **TJ** Tajikistan
- [X] **TM** Turkmenistan
- [X] **TR** Turkey
- [X] **TT** Trinidad and Tobago
- [X] **UA** Ukraine
- [X] **UG** Uganda
- [X] **US** United States of America
  United Republic of Tanzania
- [X] **UZ** Uzbekistan
- [X] **VN** Viet Nam
- [X] **YU** Yugoslavia
- [X] **ZA** South Africa
- [X] **ZW** Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- [X] DZ Algeria
- [X] AG Antigua & Barbuda
- [X] MZ Mozambique

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." [indicate the number of the Box] and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:

(i) if more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;

(ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;

(iii) if, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;

(iv) if, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;

(v) if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent of addition," or "certificate of addition," or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;

(vi) if, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI;

(vii) if, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.

2. If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.

3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures or exceptions to lack of novelty: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.

Continuation of Box No. IV

RITTER, Stephen David)
GARRATT, Peter Douglas)
COZENS, Paul Dennis)
SCHLICH, George William)
COLMER, Stephen Gary)
KAZI, Ilya)
INGRAM, Brian Victor)
SIMONS, Elisabeth Anne)
BRADLEY, Josephine Mary)
MACLEAN, Martin Robert)

All of: Mathys & Squire
100 Gray's Inn Road
London WC1X 8AL
UNITED KINGDOM

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 30 September 1999	9923174.8	United Kingdom		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present International application is the receiving Office)* identified above as item(s): (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):* ISA /

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*
Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	: 5
description (excluding sequence listing part)	: 9
claims	: 4
abstract	: 1
drawings	: 7
sequence listing part of description	:
Total number of sheets	: 26

This international application is accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify)*: 23/77

Figure of the drawings which should accompany the abstract: 2

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

.....
MOIR; MICHAEL CHRISTOPHER

Date: .....
29 September 2000

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET
Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: MCM/PWJ/21579

Applicant: HARADA INDUSTRIES (EUROPE) LIMITED

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . GBP 55.00 [T]
2. SEARCH FEE . . . . . GBP 605.00 [S]

   International search to be carried out by EPO

   (If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

   Basic Fee

   The international application contains 26 sheets.

   first 30 sheets . . . . . GBP 264.00 [b1]

   _____ (remaining sheets) x _____ (additional amount) = [b2]

   Add amounts entered at b1 and b2 and enter total at B . . . . GBP 264.00 [B]

   Designation Fees

   The international application contains ALL designations.

   8 (number of designation fees payable *(maximum 10)*) x 56 (amount of designation fee) = GBP 448.00 [D]

   Add amounts entered at B and D and enter total at I . . . . . GBP 712.00 [I]

   (Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and D.)

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . GBP 22.00 [P]

5. TOTAL FEES PAYABLE . . . . . GBP 1394.00

   Add amounts entered at T, S, I and P, and enter total in the TOTAL box — TOTAL

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

☐ authorization to charge deposit account (see below)	☐ bank draft	☐ coupons
☒ cheque	☐ cash	☐ other *(specify)*:
☐ postal money order	☐ revenue stamps	

DEPOSIT ACCOUNT AUTHORIZATION *(this mode of payment may not be available at all receiving Offices)*

The RO/ _____ ☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☐ *(this check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

2805.0049	29 September 2000	
Deposit Account No.	Date *(day/month/year)*	Signature

Form PCT/RO/101 (Annex) (January 1999; reprint July 1999)

See Notes to the fee calculation sheet

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

MOIR, Michael C.
MATHYS & SQUIRE
100 Gray's Inn Road
London WC1X 8AL
GRANDE BRETAGNE

RECEIVED
MATHYS & SQUIRE
- 4 FEB 2002
REPLY DATE
DIARY ENTERED

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	01.02.2002
Applicant's or agent's file reference: MCM/PWJ/21579 WO	**IMPORTANT NOTIFICATION**
International application No.: PCT/GB00/03746	International filing date *(day/month/year)*: 29/09/2000
Priority date *(day/month/year)*: 30/09/1999	
Applicant: HARADA INDUSTRIES (EUROPE) LIMITED et al.	

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/ European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Schmethüsen, S Tel.+49 89 2399-2567

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
MCM/PWJ/21579 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03746	29/09/2000	30/09/1999
International Patent Classification (IPC) or national classification and IPC		
H01Q9/04		
Applicant		
HARADA INDUSTRIES (EUROPE) LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 10 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
12/04/2001	01.02.2002
Name and mailing address of the International preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Dollinger, F Telephone No. +49 89 2399 7441

Form PCT/IPEA/409 (cover sheet) (January 1994)

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, pages:

1,4-7	as originally filed			
2	as received on	03/10/2001	with letter of	03/10/2001
3,3a,8,9	as received on	08/01/2002	with letter of	08/01/2002

Claims, No.:

4 (part),5,6,7 (part), 12 (part),13-19	as received on	03/10/2001	with letter of	03/10/2001
1-3,4 (part),7 (part), 8-11,12 (part)	as received on	08/01/2002	with letter of	08/01/2002

Drawings, sheets:

1/9-9/9	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

☐ the description, pages:

☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)
see separate sheet

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☒ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☐ all parts.

☒ the parts relating to claims Nos. 1-4,6,8,10,11,13,14,16,17,19.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability;

citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6,8,10,11,13,14,16,17,19
	No:	Claims	1-4
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-4,6,8,10,11,13,14,16,17,19
Industrial applicability (IA)	Yes:	Claims	1-4,6,8,10,11,13,14,16,17,19
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/GB00/03746

1. Reference is made to the following documents:

   D1: US 5 365 246
   D2: WO 99 28990
   D3: DE 29811147U

Concerning unity (Item IV)

2. According to the description on page 2 (lines 2-8) the antenna of the subject invention utilizes multiple radiating elements with a single input port; *unlike the antenna of Lui and Hall, however, the multiple radiating elements of the subject antenna are* ***not*** *connected.*
   The antenna solving this problem is specified in independent claim 5. Claims 1 and 19 are, however, silent as to the number of input ports and fail to specify which of the portions of the patch means or radiating structures are connected to input ports.

3. The second problem addressed by the application is the problem of antenna weight reduction. This problem is solved by removal of those parts of the radiating and ground elements that carry little or no surface current. The independent claims specifying this feature are claims 1 and 19.

4. It is accordingly clear that the subject matter of claims 1 and 19 on the one hand and the subject matter of claim 5 on the other hand address different problems and specify different antennas and are therefore not so linked as to form a single general inventive concept as prescribed by Rule 13.1 PCT.

Concerning clarity (Item VII)

5. Whereas claim 19 specifies *two radiating structures having electromagnetic interaction* all embodiments presented in the application show antennas having more than two structural elements.
   Moreover, as the combination of the structural elements acts as one single radiating structure due to the electromagnetic interaction, no reasonable division

into separate radiating structures seems to be possible at all.

Claim 19 is in that respect unclear and unsupported by the description.

Claim 19 is further rendered unclear by the term *relatively low.*

Claims does not therefore conform to the requirement of Article 6 and Rule 6.3(a) PCT.

6. The expression at lines 3-5 of claim 1, concerning the geometrical relationship between the patch means and the ground member, is not clear. As follows from the original application documents, and confirmed by the Applicants' submissions dated 8/1/2002, the portions of the patch means are parallell to and spaced apart from the ground member. However, the expression of claim 1 above mentioned does not convey such a geometrical relationship, but it appears to define that the first and second portions of the patch are parallel to each other, no mention being made of the parallelism with the ground plane. It is furthermore considered that the amendment extends beyond the content of the application as filed.

Taking into account Rule 70.2 (c), it is considered that the amendment objected to has not been made, and the subject-matter of the claim will be understood in this respect along the lines of the passage underlined above.

7. The current paths claims 1 and 2 refer to are uniquely fixed by the boundary conditions imposed by the ground member and by the discrete first and second portions of the patch means without the claimed shaping. Removal of parts of the ground member and/or of the portions of the patch means will affect the resonance frequencies and the current paths.

Claims 1 and 2 do not therefore define the matter for which protection is sought in terms of the technical features of the invention but by the technical features of a completely undefined precursor of the invention (i.e. the state of the art or an imaginary previous step in production or design).

Claims 1 and 2 refer to shaping in general whereas description and figures only refer to shaping as far as removing of material is concerned. Claims 1 and 2 are in that respect not supported by the description (PCT Guidelines, III-6.1).

Claims 1 and 2 do not therefore conform to the requirement of Article 6 and Rule 6.3(a) PCT.

8. From the passage bridging page 6 and 7 of the description it is clear that the nub of the invention lies in the fact that those parts of the antenna (i.e. the patch means and/or ground member) which carry little or no current may be removed, thus reducing weight of the antenna.

Claims 1 and 2 do not, however refer to the removal of these parts but only to the shaping of "conduction surfaces" thereof. In this respect claim 1 makes a distinction where there seems to be no difference, i.e. the introduction of the notion "conduction surfaces" is superfluous and renders the scope of claim 1 unclear (Article 6 PCT).

Claims 1 and 2 do not therefore conform to the requirement of Article 6 PCT.

9. Regarding claim 4 the terms "generally central position" and "proximate the one end" are too vague and imprecise. It is furthermore not clear in respect of what the position is "(generally) central". Moreover the formulation "one end of each first and second patch corresponding to the one end of the patch means" leaves unclear how the patches are to be positioned and what "corresponding" means with respect to positioning of edges.
Claim 4 is for these reasons not clear (Article 6 PCT).

10. The terms "the one end" and "an other-end member" are equivocal, rendering the subject-matter of claims 4 and 11 unclear.

11. Claims 4, 6, 8, 10, 16 are rendered unclear by the vague and imprecise terms "generally", "proximate" and "approximating".

12. Most of the features of claims 16 and 17 relate to a process of producing the apparatus rather than clearly defining the apparatus in terms of its technical features. The intended limitations are therefore not clear from these claims (PCT Guidelines, PCT/GL/3/ III, 4.7).

Concerning novelty and inventive step (item V).

13. Notwithstanding the above raised objections on clarity the following comments are proffered on the invention.

Document D1, which is considered to represent the closest prior art discloses a dual-band antenna comprising at least two structural elements (figures; column 4, lines 45-46).

The only feature of independent claim 19 not disclosed in D1 is that at least one of the structural elements is apertured.

This feature solves the problem of weight reduction as disclosed in document D3 (page 2, line 4). D3 further solves this problem in the same way as the application, i.e. by the provision of apertures (page 2, first paragraph; claims; figure 1). The apertures are distributed over the whole antenna of D3 and are therefore inevitably located at locations where, if apertures were not present, induced currents would be relatively low compared to currents in other parts of the structure.

The skilled person wishing to reduce the weight of the antenna known from document D1 would apply the technical teaching known from document D3 thus arriving at the subject matter of claim 19 which seems accordingly not to be inventive under Article 33(3) PCT.

14. Document D1 discloses a dual-band microstrip antenna comprising
- a ground member (column 1, line 61)
- patch means having discrete first and second portions which are parallel to each other and spaced apart from the ground member (figure 5)
- first and second resonant frequency ranges (column 4, lines 45-46)

Every microstrip antenna is realized in a shaping process set up in a way to achieve desired functional parameters (e.g. resonant frequency, bandwidth). This shaping leads to conduction surfaces with an appropriate current flow pattern, irrespective of whether the current flow pattern was used as a design parameter or not. If a shaping process would change the patterns of current flow, the functional parameters of the antenna would be changed.

Accordingly conduction surfaces of patch means of every microstrip antenna

are shaped to substantially correspond to the patterns of current flow before such shaping.

Independant claim 1 specifies no further technical features. The subject-matter of claim 1 seems accordingly not to be novel under Article 33(2) PCT.

It is to be noted that even if the subject-matter of claim 1 would be regarded as being novel it still seems not to be inventive in view of D3 and the argumentation as set out on the subject-matter of claim 19 above.

15. D1 further comprises
- the ground member having a rectangular outer profile (figure 5)
- sides of patch means and ground member being in alignment (figure 5)
- a pair of second patches each positioned adjacent a respective opposite side of the first patch (figure 5)
- signal feedline being connected to central position on the first patch (figure 5)
- shorting member extending from each second patch to the ground member (figure 5)

As dependant claims 2, 3 and 4 specify no further features, the subject-matter of these claims seems accordingly not to be novel under Article 33(2) PCT.

16. The definition of antenna parameters by appropriate selection of width and length of patch dimensions is well known to the skilled person and disclosed in figure 3 of document D2, showing a secondary patch having approximately half the width of the first patch.
As it is obvious to apply this teaching to the antenna of D1 the subject-matter of claim 6 seems not to be inventive.

17. The subject-matter of claims 8, 10 and 11 deals with trivial modifications of the apertures formed in the elements of the antenna.
As the same reasoning as set out under 12. above holds for the subject-matter of claims 8, 10 and 11, they seem not to be inventive.

18. As the application of coaxial cables and printed circuit boards is well known in the

design of microstrip antennas the subject-matter of claims 13, 14, 16 and 17 is not inventive.

IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *With international search report.*

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DUAL-BAND MICROSTRIP ANTENNA

The invention relates to a dual-band antenna, and provides a dual-band microstrip antenna that has ground and patch elements configured such that the contour of the surface areas of the elements substantially corresponds to the pattern of induction currents created in the elements by signals in the dual bands.

One important use of dual-band microstrip antennas is in mobile communication systems. A common configuration for an antenna in such use is the inverted-F geometry which is described in two articles by Zi Dong Liu and Peter S. Hall. The first article is "Dual-band antenna for hand held portable telephones", Electronics Letters, Vol. 32, No. 7, pp. 609-610 (March 1996), and the second (and more comprehensive) is "Dual-Frequency Planar Inverted-F Antenna", IEEE Transactions on Antennas and Propagation, Vol. 45, pp. 1451-1457 (October 1997).

Liu and Hall describe two dual-frequency-band antenna configurations, one with a single input port and the other with two input ports. The two-port antenna consists of two co-planar radiating elements -- the first one being rectangular and the second one being L-shaped and having two sides adjacent the first one. The rectangular element is for 1.8 GHz signals, while the L-shaped element is for 0.9 GHz signals. This configuration of dual-band antenna is about the same size as a single-band inverted-F antenna for 0.9 GHz signals. Both the rectangular element and the L-shaped element have one end shorted to the ground plane. Because the two radiating elements are not connected, the coupling between the two antennas is small and only due to fringe-field interaction. A variation has a single input port connected to an intermediate point of connection between the rectangular element and the L-shaped element. Although it has the advantage of using only a single input port, this arrangement has the drawback that the coupling

between the rectangular element and the L-shaped element is increased.

As with the variation of the dual-frequency-band antenna of Lui and Hall, the antenna of the subject invention utilizes multiple radiating elements with a single input port; unlike the antenna of Lui and Hall, however, the multiple radiating elements of the subject antenna are not connected. The antenna of the subject invention has the advantages over that of Lui and Hall of having only two shorting points and a much-increased bandwith. In addition, portions of the radiating and ground elements that carry little or no surface current are removed, resulting in weight reduction and a degree of transparency. A further advantage is that the dual-band antenna of the invention is capable of being mass-produced at low cost using flexible printed circuit board.

In one form, the invention is a dual-band microstrip that includes a ground member and patch means having discrete first and second portions and which is in a generally parallel spaced relationship with the ground member. First and second resonant frequency ranges being defined by the electromagnetic interaction between the patch means and the ground member. Conduction surfaces of the portions of the patch means are shaped so as to substantially correspond to current paths that signals within the first and second resonant frequency ranges would induce in the conduction surfaces without such shaping. Conduction surfaces of the ground member may be shaped in a similar manner.

In the antenna, sides and one end of the patch means may be in respective alignment with sides and one end of the ground member. The first portion of the patch means may be a first patch, and the second portion of the patch means may be a pair of second patches each having a side adjacent a respective opposite side of the first patch. One end of each first and second patch corresponds to the

one end of the patch means. An antenna signal feedline is connected to a generally central position on the first patch, and a shorting member extends from each second patch to the ground member at a point proximate the one end of the second patch and the ground member.

Each second patch may have a length approximating the length of the first patch, and a width approximating one-half the width of the first patch. The first patch may be generally configured as an 'H', with the sides of the first patch corresponding to side members of the 'H'.

In a first construction, the conducting surfaces of the ground member may be configured as a hollow generally rectangular structure, with a cross-piece extending between the sides of the structure at a projection of the position at which the antenna signal feedline connects to the first patch. In a second construction, the conducting surfaces of the ground member may be defined by two side members and an other end member and with a cross-piece extending between the two side members at a projection of the position at which the antenna signal feedline connects to the first patch. In the second construction, extensions of the side members of the first patch extend from the one end of the patch means to the plane of the ground member and then in the plane of the ground member for a part of the distance toward the cross-piece.

A coaxial cable may be attached to the antenna such that a ground portion of the cable is connected to the cross-piece of the ground member, and such that a signal feed portion of the cable defines the antenna signal feedline attached to the first patch.

The antenna may be formed from printed circuit board having a conductive layer on one side. The conducting surfaces of the ground member are formed by removing portions of a conductive layer on the one side of a first segment of the circuit board. The conducting surfaces of the patch means are formed by removing portions of the

conductive layer on the one side of a second segment of the board. The first and second segments of the circuit board are then mounted in parallel spaced relationship. In the first construction, shorting members are applied between the ground member and the second patches proximate the one end of the ground member and the second patches, whereas in the second construction, shorting members are applied between the one end of the ground member and the one end of the first and second patches.

In another form, the invention is a dual-band microstrip antenna that includes a ground member and first and second portions of a patch means. The patch means is in a generally parallel spaced relationship with the ground member. First and second resonant frequency ranges are defined by the electromagnetic interaction between the patch means and the ground member. Sides and one end of the patch means are in respective alignment with sides and one end of the ground member. The first portion of the patch means is a first patch, and the second portion of the patch means is a pair of second patches each positioned adjacent a respective opposite side of the first patch. One end of each first and second patch corresponds to one end of the patch means. An antenna signal feedline is connected to a generally central position on the first patch, and a shorting member extends from each second patch to the ground member at a point proximate the one end of the second patch and the ground member.

The invention will next be more fully described by way of example only, by means of preferred embodiments, utilizing the accompanying drawings, in which:

Figure 1 is a perspective view of a typical prior art inverted-F antenna adapted to operate over a single frequency band;

Figure 2 is a perspective view of an embodiment of the dual-band microstrip antenna of the invention;

Figure 3 is an illustration of the surface currents

on the antenna of Figure 2 at a radiating frequency of 925 Megahertz;

Figure 4 is an illustration of the surface currents on the antenna of Figure 2 at a radiating frequency of 1800 Megahertz;

Figure 5 is a perspective view of another embodiment of the microstrip antenna of the invention, the antenna being similar to Figure 2 but having excess metal removed from the ground plate and the patch plates;

Figure 6 is a further embodiment of the microstrip antenna of the invention, the antenna being a slightly-modified version of the antenna of Figure 5;

Figure 7 is a top view of a ground plate of the further embodiment of the antenna of the invention;

Figure 8 is a top view of the patches of the further embodiment of the antenna of the invention;

Figure 9 is a side or cross view of the further embodiment of the microstrip antenna of the invention;

Figure 10 is a graph illustrating the return loss for the antennas shown in Figures 2 and 5;

Figure 11 is an illustration of the radiation patterns obtained in the YZ plane (based on the axes orientation shown in Figure 2) for the antenna of the embodiment shown in Figures 6 to 9, measured at 925 MHz and 1800 MHz;

Figure 12 is an illustration of the radiation patterns obtained in the XZ plane (based on the direction of axes shown in Figure 2) for the antenna of the embodiment shown in Figures 6 to 9, measured at 925 MHz and 1800 MHz; and,

Figure 13 is an illustration of a further embodiment of the dual-band antenna of the invention, that antenna having a wrap-around first patch.

Referring first to Figure 1, the typical prior art inverted-F antenna operating on a single frequency band has a ground plate 20 of length L that is connected to a

patch plate 22 of length P through a shorting plate 24 of height H; the three plates 20, 22 and 24 all have a width W. A feed pin 26, which is an extension of the centre wire of a coaxial cable (not shown) that has its ground wire connected to ground plate 20, connects to a central position on the patch plate 22. The length P of patch plate 22 approximates one-quarter wavelength at the mid-range of the frequency band of the antenna. The metallic surface of ground plate 20 may be provided by the metallic side of a portable telephone or other device on which the antenna is used.

Prior to removal of metal from the ground plate and the radiating patches, an embodiment of the dual-band microstrip antenna has, as shown in Figure 2, a ground plate 30, a central patch plate 32, a pair of side patch plates 34, and a pair of shorting strips 36 each of which connects a respective side patch plate 34 to the ground plate 30. A feed pin 38, which as with feed pin 26 in Figure 1 is an extension of the centre wire of a coaxial cable (not shown), connects to a central position on the central patch plate 32; a ground wire of the coaxial cable is connected to the ground plate 30. The connection point of feed pin 38 and the lengths of patch plates 32 and 34 are experimentally adjusted until the desired antenna bandwidths and a 50-ohm impedance match with the coaxial cable are obtained. As shown, the side patch plates 34 are each narrower and slightly shorter than the central patch plate 32. Figure 2 illustrates the orientation of the antenna with respect to a X-Y-Z co-ordinate system that has application to the radiation patterns shown in Figures 11 and 12.

When the surface currents on conductive material of the antenna of Figure 2 were measured in the frequency ranges of 925 MHz (Figure 3) and 1800 MHz (Figure 4), it was found that little or no surface current was present on large areas of the conductive material at either frequency

range. Those areas of the conductive material therefore contribute to the weight but not to the performance of the antenna, and may be removed. Removal of that material has also been found to improve the bandwidth.

Figure 5 illustrates the antenna of Figure 2 after removal of the conductive material that was found to carry little or no surface current in the two frequency bands of interest. A central portion of ground plate 30 has been removed except for a cross-piece 40 to which a signal carrier, such as a coaxial cable, is connected. Two central sections of the central patch plate 32 have also been removed -- giving the central patch plate 32 an 'H' configuration.

The embodiment of the antenna in Figure 6 differs from the one shown in Figure 5 in the type and placement of the shorting means; except for the shorting means, the numbering of parts in both is the same. The shorting means differs between the embodiments of Figures 5 and 6 in that each shorting pin 42 in the Figure 6 embodiment is not connected between the end of the ground plate 30 and the end of a respective side patch plate 34, but instead is connected at positions removed from the ends. Each shorting pin 42 extends (as shown in Figures 7 and 8) between a hole 44 on ground plate 30 and a hole 46 on a respective side patch plate 34. The signal feed pin 38 extends through the large hole 48 in cross-piece 40. A top view of the ground conducting plate is shown in Figure 7, and a top view of the patch plates is shown in Figure 8. A side or cross view of the antenna of Figure 6 is shown in Figure 9, in which a connector 50 for connecting a coaxial cable or other signal carrier to the ground plate 30 is shown.

The numbers adjacent the arrows in Figures 7 to 9 represent in millimetres the dimensions of the ground plate 30 and the patch plates 32, 34 in the antenna of this preferred embodiment -- as well as their relative

spacing. The ground plate is 13.5 cm. long and 20 cm. wide, the central patch plate 32 is 86.75 mm. long and 8 mm. wide, and the side patch plates 34 are each 82 mm. long and 3 mm. wide. The width of the spacing between the central patch plate 32 and each side patch plate 34 is 2 mm. Each of the holes 44 and 46, to which the shorting pins 42 connect, is 12 mm. from the end of the respective ground plate 30 and side patch plate 34.

Figure 10 illustrates the difference in return loss between the antennas of Figures 2 and 5. At the two resonant frequencies, the return loss can be seen to be greater in the antenna with metal removed (solid line) than in the antenna without metal removed (dotted line). Measured radiation patterns in the YZ and XZ planes (with reference to the co-ordinate system in Figure 2) for the antenna emboidment of Figures 6 to 9 are shown in Figures 11 and 12, respectively.

Figure 13 illustrates a further preferred embodiment of the antenna of the invention. It differs from the embodiment shown in Figures 6 to 9 in that the central patch plate 32 has a wrap-around configuration in which one end of a hollow ground plate 30 has been removed, and the sides of the central patch plate 32 have been extended across to the plane of the ground plate 30 and then a part of the distance toward the cross-piece 40 in that plane.

While the present invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation, and that changes may be made to the invention without departing from its scope as defined by the appended claims.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated into the invention independently of other disclosed and/or illustrated features.

The text of the abstract filed herewith is repeated

here as part of the specification.

A dual-band microstrip antenna has a ground plate and also has a central patch positioned between a pair of side patches. The antenna has a single signal feedline, connected to the central patch, and the side patches are shorted to the ground element. Conductive surfaces of the ground plate and patches that carry surface current from signal radiation are contoured such that only portions of conductive surfaces that carry more than a negligible amount of the surface current are retained. The antenna has a reduced weight and improved bandwidth over conventional antennas that operate in the 925 MHz and 1800 MHz ranges.

CLAIMS:

1. A dual-band microstrip antenna comprising:

a ground member; and,

patch means having discrete first and second portions and which is in a generally parallel spaced relationship with the ground member, first and second resonant frequency ranges being defined by the electromagnetic interaction between the patch means and the ground member; wherein conduction surfaces of the portions of the patch means are shaped so as to substantially correspond to current paths that signals within the first and second resonant frequency ranges would induce in the conduction surfaces without such shaping.

2. An dual-band microstrip antenna as in claim 1, wherein conduction surfaces of the ground member are shaped so as to substantially correspond to current paths that signals within the first and second resonant frequency ranges would induce in those conduction surfaces without such shaping.

3. A dual-band microstrip antenna as in claim 1 or 2, wherein the ground member has a rectangular outer profile and wherein sides and one end of the patch means are in respective alignment with sides and one end of the ground member.

4. A dual-band microstrip antenna as in claim 3, wherein the first portion of the patch means is a first patch, wherein the second portion of the patch means is a pair of second patches each positioned adjacent a respective opposite side of the first patch, one end of each first and second patch corresponding to the one end of the patch means, wherein an antenna signal feedline is connected to a generally central position on the first

patch, and wherein a shorting member extends from each second patch to the ground member at a point proximate the one end of the second patch and the ground member.

5. A dual-band microstrip antenna comprising:

a ground member; and,

first and second portions of a patch means that is in a generally parallel spaced relationship with the ground member, first and second resonant frequency ranges being defined by the electromagnetic interaction between the patch means and the ground member;

wherein sides and one end of the patch means are in respective alignment with sides and one end of the ground member, wherein the first portion of the patch means is a first patch and the second portion of the patch means is a pair of second patches, each second patch having a side adjacent a respective opposite side of the first patch, one end of each first and second patch corresponding to the one end of the patch means, wherein an antenna signal feedline is connected to a generally central position on the first patch, and wherein a shorting member extends from each second patch to the ground member at a point proximate the one end of the second patch and the ground member.

6. A dual-band microstrip antenna as in claim 4 or 5, wherein each second patch has a length approximating the length of the first patch, and has a width approximating one-half the width of the first patch.

7. A dual-band microstrip antenna as in claim 6, wherein the first patch is generally configured as an 'H', with the sides of the first patch corresponding to side members of the 'H'.

8. A dual-band microstrip antenna as in claim 4,

wherein the conducting surfaces of the ground member is configured as a hollow generally rectangular structure, with a cross-piece extending between the sides of the structure at a projection of the position at which the antenna signal feedline connects to the first patch.

9. A dual-band microstrip antenna as in claim 7, wherein the conducting surface of the ground member is defined by two side members and an other end member and with a cross-piece extending between the two side members at a projection of the position at which the antenna signal feedline connects to the first patch, and wherein extensions of the side members of the first patch extend from the one end of the patch means to the plane of the ground member and then in the plane of the ground member for a part of the distance toward the cross-piece.

10. A dual-band microstrip antenna as in claim 8 or 9, wherein a coaxial cable is attached to the antenna such that a ground portion of the cable is connected to the cross-piece of the ground member, and such that a signal feed portion of the cable defines the antenna signal feedline attached to the first patch.

11. A dual-band microstrip antenna as in claim 8, wherein the antenna is formed from printed circuit board having a conductive layer on one side, wherein the conducting surfaces of the ground member are formed by removing portions of the conductive layer on the one side of a first segment of the circuit board, wherein the conducting surfaces of the patch means are formed by removing portions of the conductive layer on the one side of a second segment of the circuit board, and wherein the first and second segments of the circuit board are then mounted in parallel spaced relationship, and shorting members are applied between the ground member and the

second patches proximate the one end of the ground member and the second patches.

12. A dual-band microstrip antenna as in claim 9, wherein the antenna is formed from printed circuit board having a conductive layer on one side, wherein the conducting surfaces of the ground member are formed by removing portions of the conductive layer on the one side of a first segment of the circuit board, wherein the conducting surfaces of the patch means are formed by removing portions of the conductive layer on the one side of a second segment of the circuit board, wherein the first and second segments of the circuit board are then mounted in parallel spaced relationship, and wherein shorting members are applied between the one end of the ground member and the one end of the first and second patches.

13. A dual-band microstrip antenna comprising at least two interconnected conductive radiating structures, at least one of the structures being apertured at locations where, if apertures were not present, induced currents would be relatively low compared to currents in other parts of the structure.

10/089532

FIG. 1

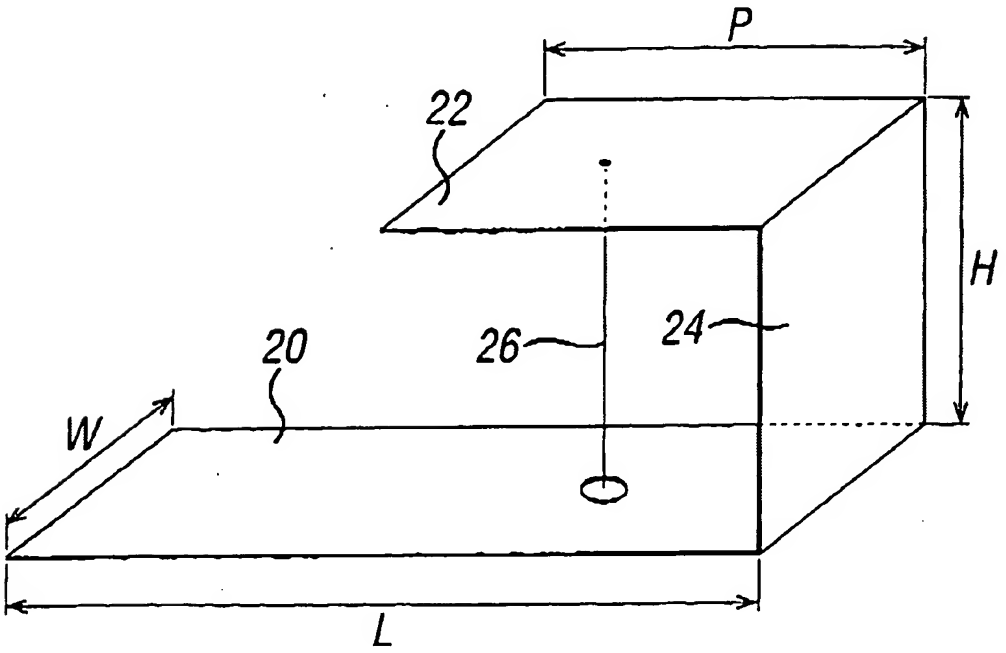
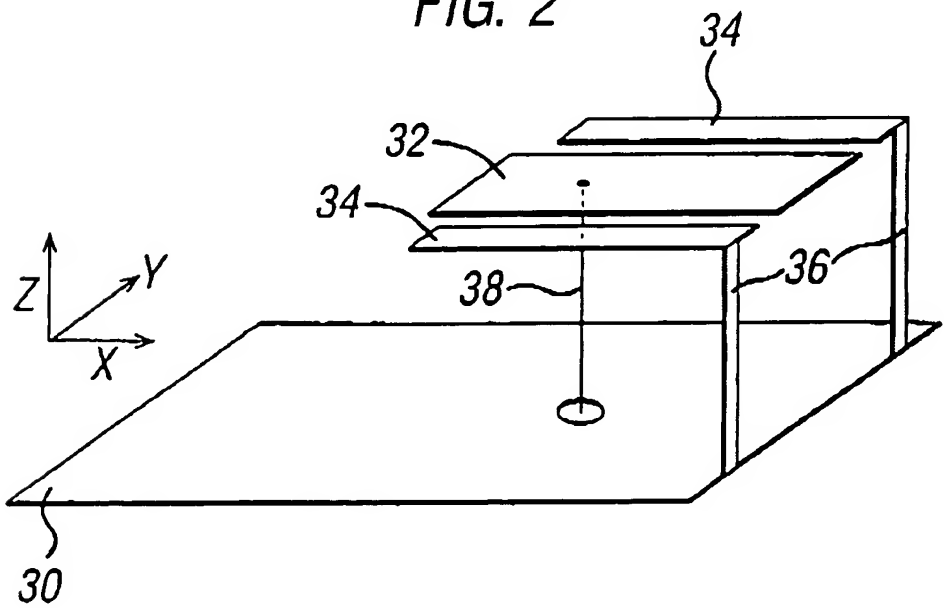
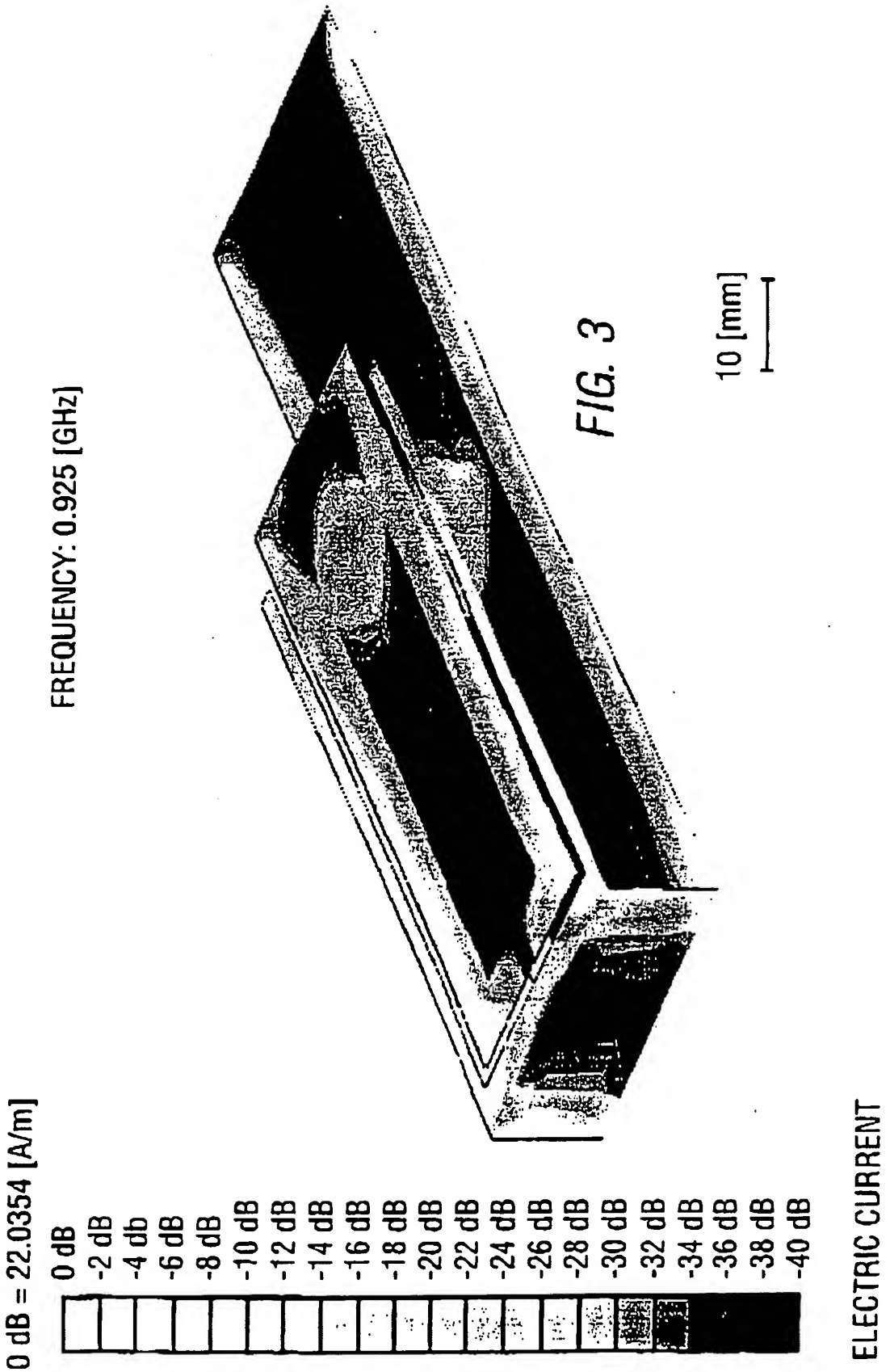


FIG. 2

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-2 dB
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-16 dB
-18 dB
-20 dB
-22 dB
-24 dB
-26 dB
-28 dB
-30 dB
-32 dB
-34 dB
-36 dB
-38 dB
-40 dB
ELECTRIC CURRENT

FIG. 3

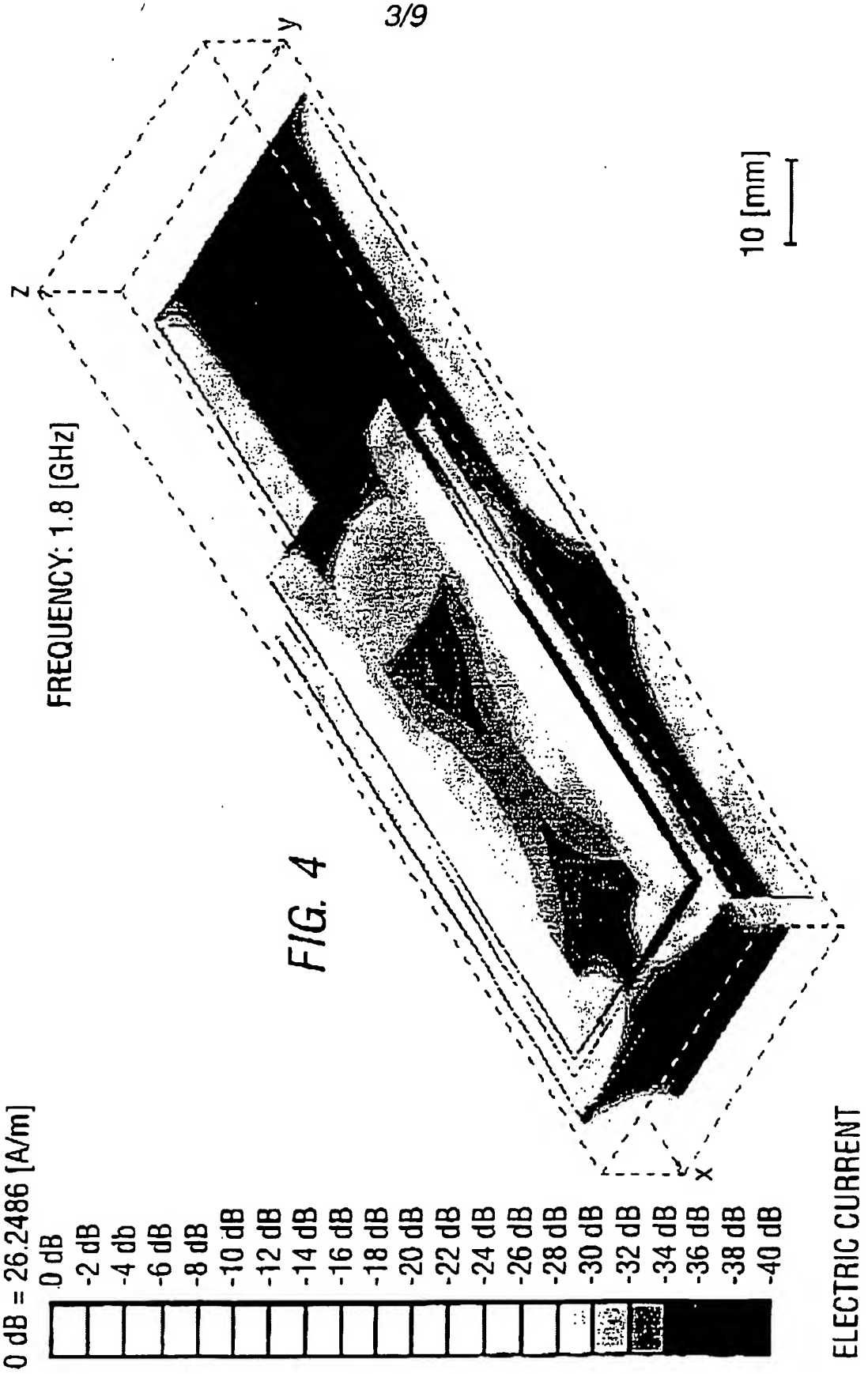

y
z
x
10 [mm]
FREQUENCY: 1.8 [GHz]
0 dB = 26.2486 [A/m]
0 dB
-2 dB
-4 db
-6 dB
-8 dB
-10 dB
-12 dB
-14 dB
-16 dB
-18 dB
-20 dB
-22 dB
-24 dB
-26 dB
-28 dB
-30 dB
-32 dB
-34 dB
-36 dB
-38 dB
-40 dB
ELECTRIC CURRENT

FIG. 4

10/089532

FIG. 5

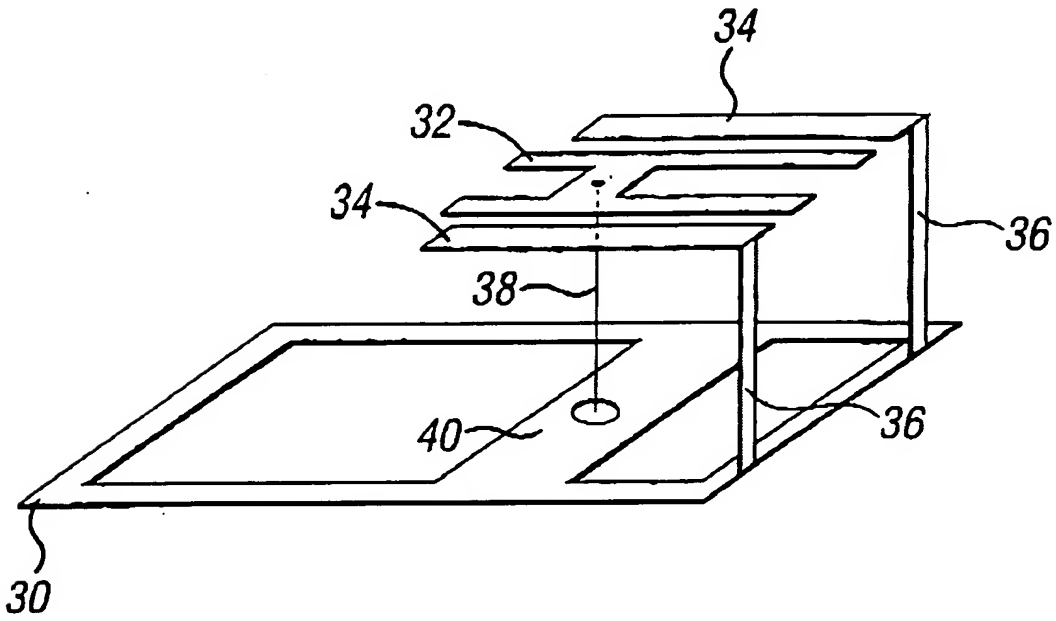


FIG. 6

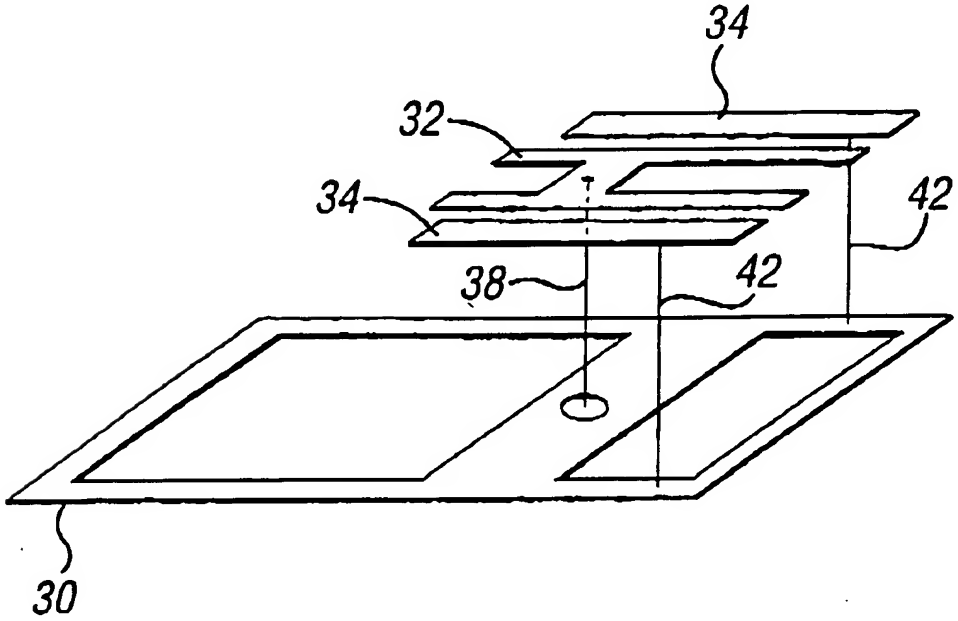


FIG. 7

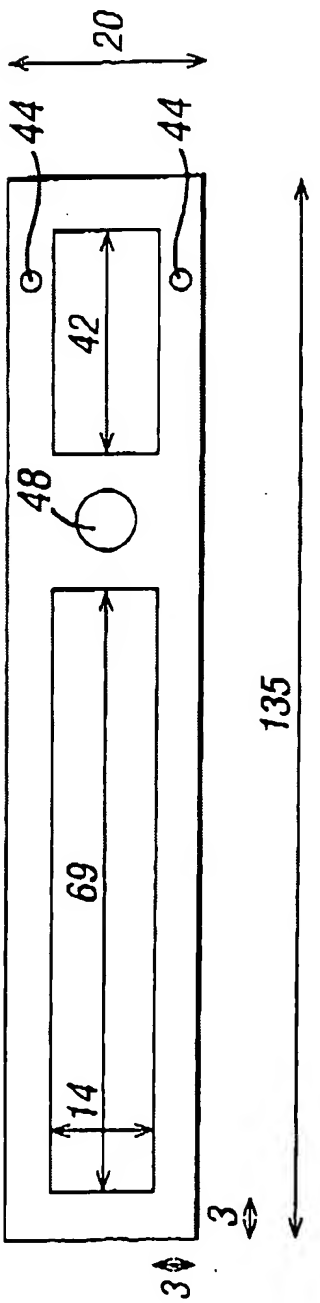


FIG. 8

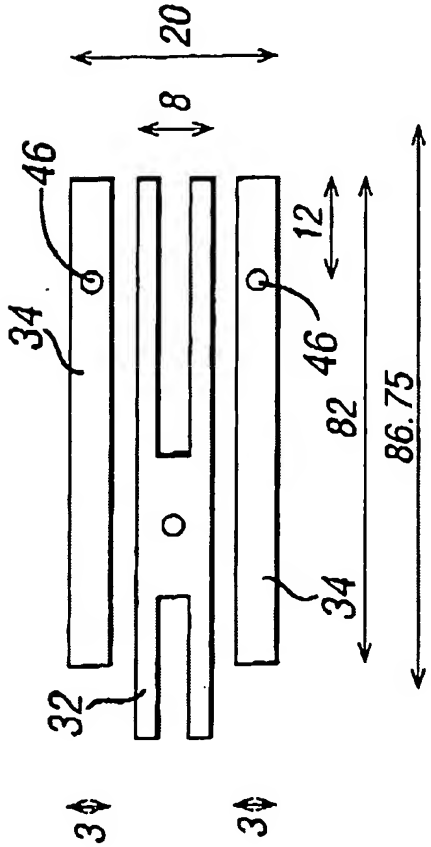
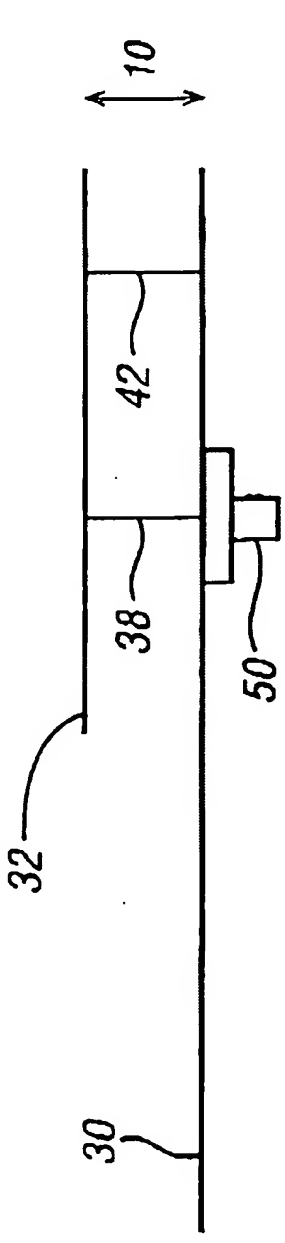


FIG. 9



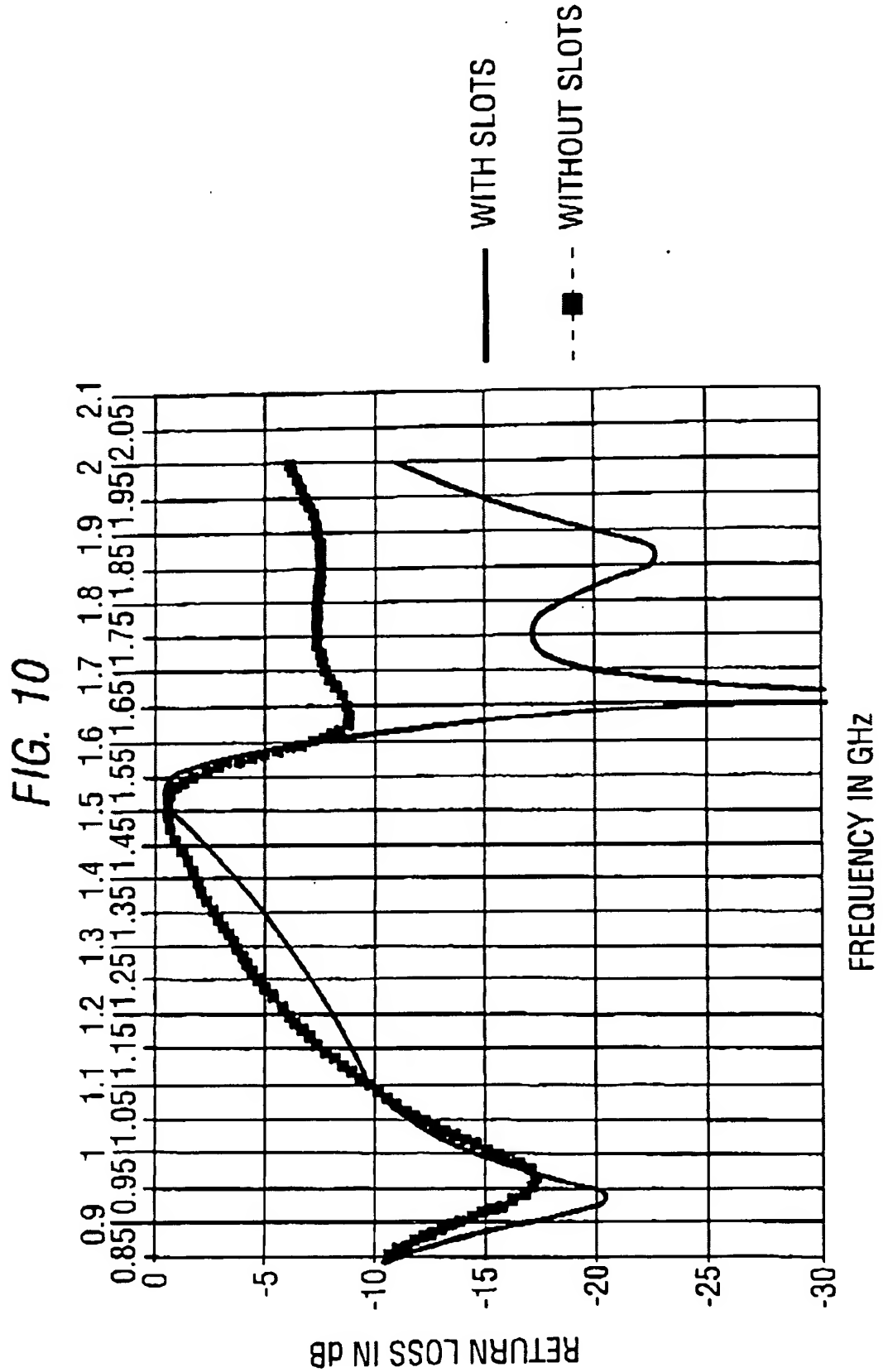
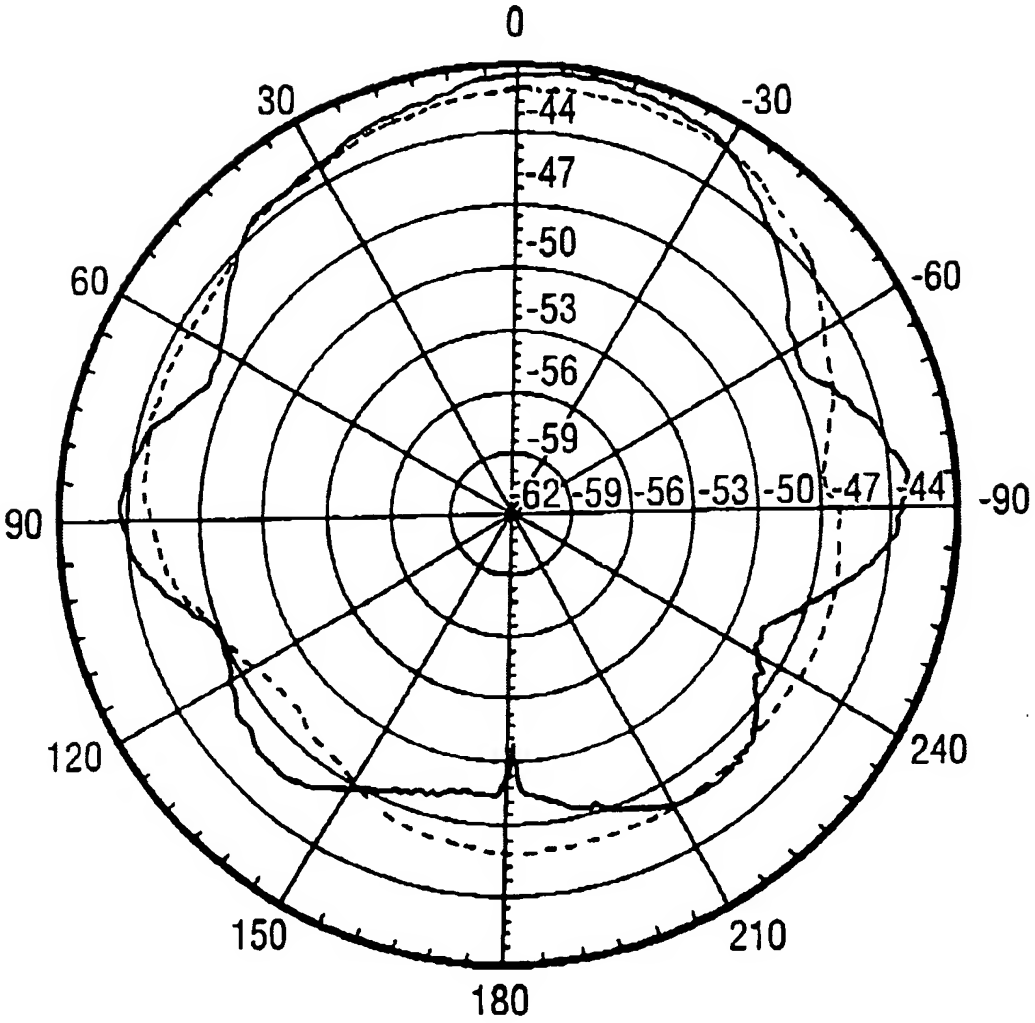

WITH SLOTS
WITHOUT SLOTS
0.85
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
1.85
1.9
1.95
2
2.05
2.1
0
-5
-10
-15
-20
-25
-30
RETURN LOSS IN dB
FREQUENCY IN GHz

FIG. 10

FIG. 11

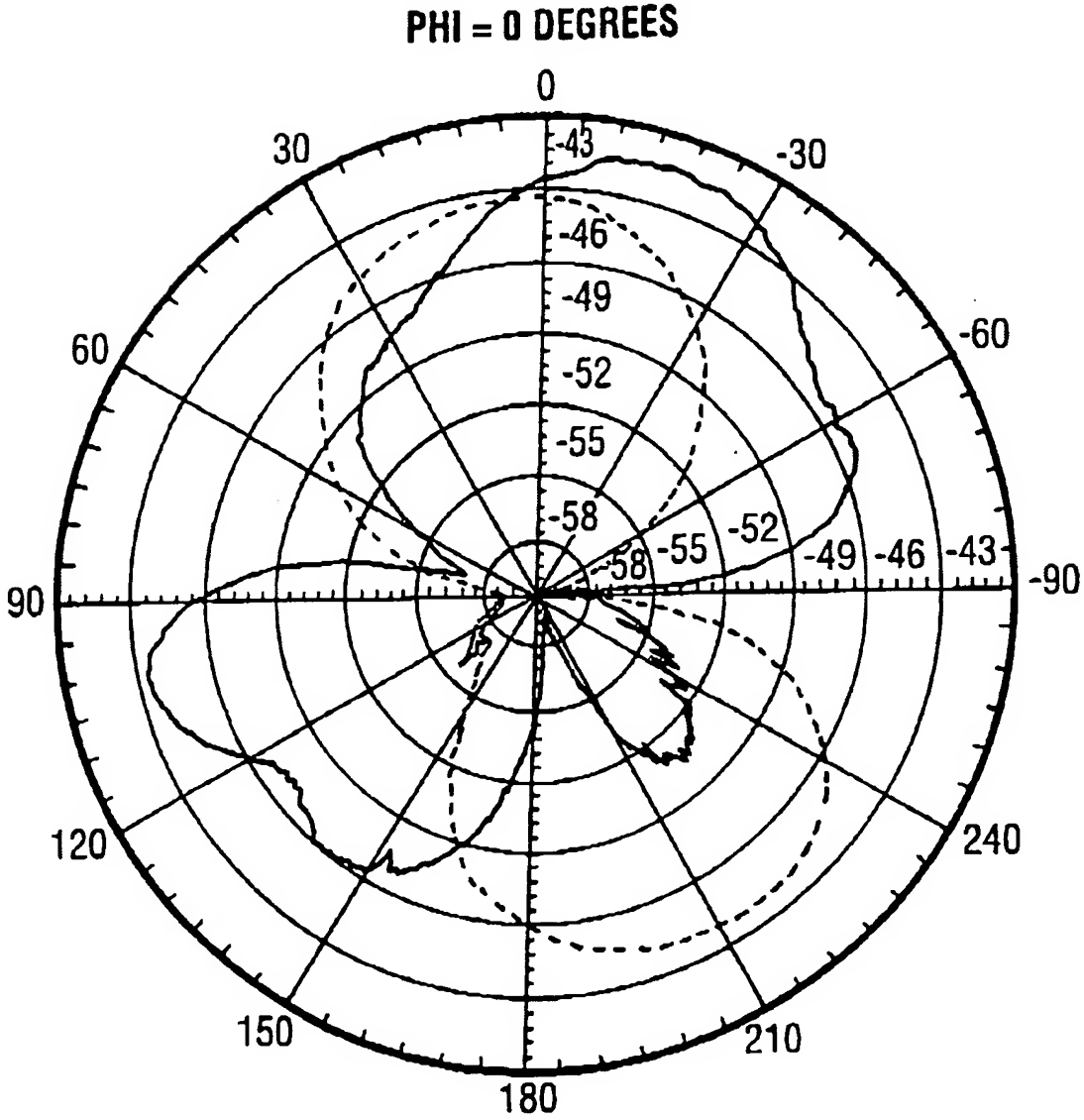


MEASURED RADIATION PATTERNS IN YZ PLANE

----- F = 925 MHz :COPOLARIZATION

——— F = 1.8 GHz :COPOLARIZATION

FIG. 12



MEASURED RADIATION PATTERNS IN XZ PLANE

----- 925 MHz COPOLARIZATION

——— 1.8 GHz COPOLARIZATION

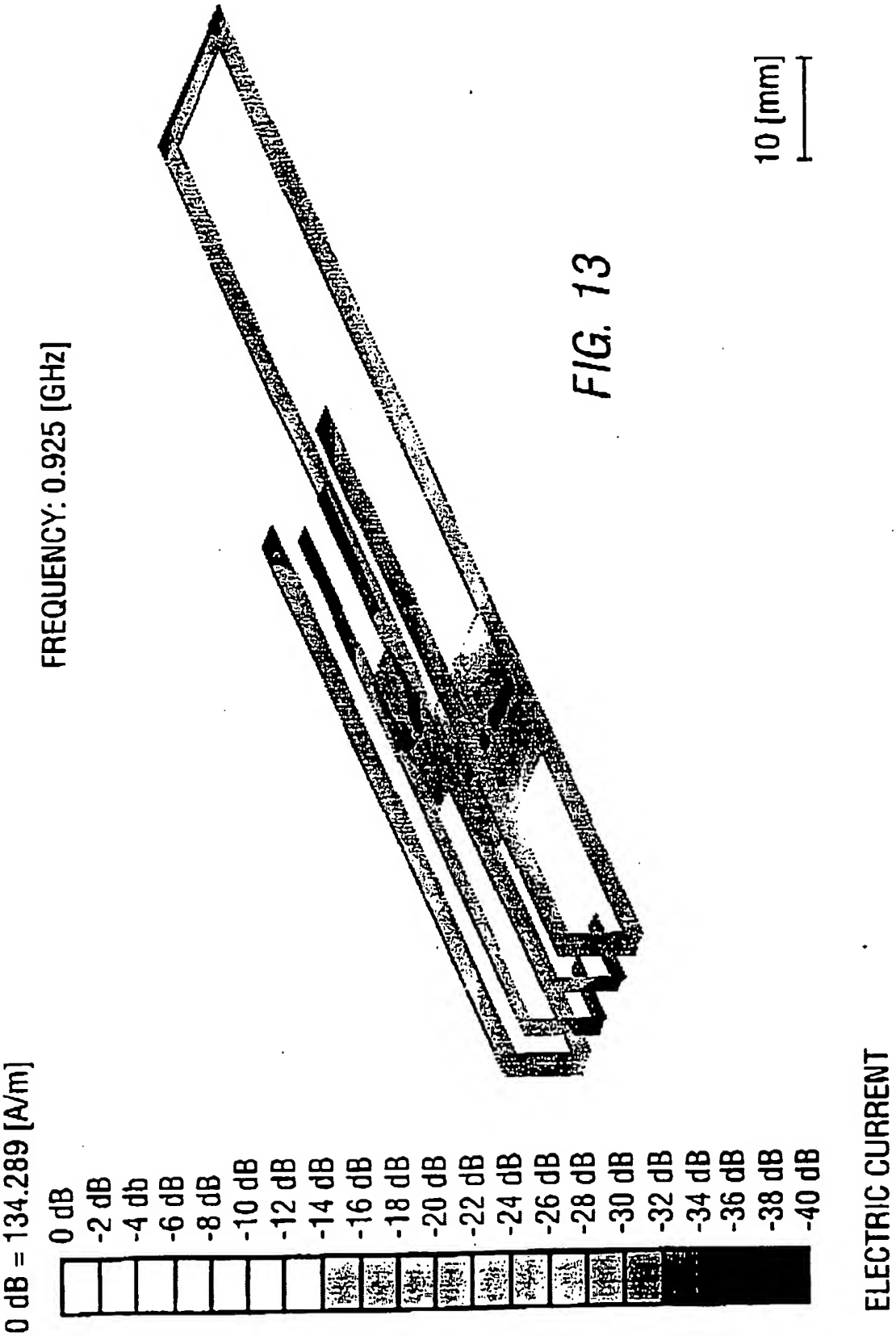

FREQUENCY: 0.925 [GHz]
10 [mm]
0 dB = 134.289 [A/m]
0 dB
-2 dB
-4 db
-6 dB
-8 dB
-10 dB
-12 dB
-14 dB
-16 dB
-18 dB
-20 dB
-22 dB
-24 dB
-26 dB
-28 dB
-30 dB
-32 dB
-34 dB
-36 dB
-38 dB
-40 dB
ELECTRIC CURRENT

FIG. 13